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(54) IMPROVEMENTS IN OR RELATING TO PROXIMITY DETECTORS

(71) We, THORN DOMESTIC APPLIANCES (ELECTRICAL) LIMITED, a British Company of Thorn House, Upper Saint Martins Lane, London, WC2H 9ED, England, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to proximity detectors.

Conventional proximity detectors usually comprise an insulating plate, to a first surface of which is attached an electrode connected to a switching circuit. The second surface of the plate is arranged so as to be accessible by the operator and so that the change in the electrical field caused by placing his finger either in contact with the second surface of the plate or in close proximity thereto, is detected by the electrode on the first surface of the plate. The change in electric field around the electrode caused by the presence of the operator's finger on the second surface of the plate may be detected in a number of ways. For example, it is possible to connect the electrode to a circuit which detects the operator's finger by sensing that the electrode is capacitively coupled to earth by the presence of the operator's finger. Other detection circuits have been proposed which detect the presence of the operator's finger by sensing the mains frequency alternating current which is capacitively coupled to the electrode by the operator's finger acting as an "aerial" picking up the stray mains field in the room in which the detector is located.

One of the difficulties with proximity detectors of the above described type is that of causing the proximity detector to switch reliably. Such proximity detectors can be subject to great changes in sensitivity according to the variations in ambient contions such as, for example, humidity. In particularly humid environments, such as kitchens it is even possible for proximity detectors to be triggered by condensation on the sensitive areas thereof. Furthermore, there is also the difficulty that an operator will rarely be consistent in the manner in which he applies his finger to the proximity detector; there may be large variations in, for example, the pressure with which the operator applies his finger, the area of contact between finger and detector and the operator's skin resistance. All these factors have made it difficult to produce proximity detectors which will behave reliably in environments such as kitchens where for example the detectors may be used to control the heating elements of electric cookers.

According to the present invention there is provided a proximity detector having a front, surface which, in normal use, faces an operator and including an insulating plate member having first and second major faces which in normal use face away from and towards an operator, respectively, at least one first electrode on the first face of the insulating plate and at least one second electrode on the second face of the insulating plate, the or each first electrode being capacitively coupled with the or the respective second electrode through the plate, the or each second electrode defining a or a respective proximity sensing area on said front surface of the detector whereby the or the respective first electrode is responsive, to produce an output signal, both to the presence of an operator's finger in contact with such area and to the presence of such finger in close proximity to the, or the respective, such area, only the or each electrode on said first face of the insulating plate member having an electrical connection for coupling to an electrical circuit.

Preferably the insulating member is a glass sheet.

The provision of the second electrode represents an improvement over known proximity detectors in that when a finger is applied to the sensitive area, the capacitive coupling between the first and second elec-

trodes is independent of the shape or size of the finger or the manner in which it is applied to the second electrode. The sensitive area can be on a surface of the second electrode itself or on the surface of a layer of non-conducting lacquer applied to the surface of the second electrode.

Such a proximity detector may be used to control a power control apparatus such as that described and claimed in the parent Application No. 8392/73 (Serial No. 1,464,093), which apparatus includes a memory for storing a variable numerical value, the memory being arranged so that increases and decreases in the numerical value stored are controlled by first and second control inputs respectively of the memory; means connected to an output of the memory for varying the rate of energy supply to a load in dependence on the value stored in the memory, so that each value corresponds to a respective rate of energy supply; first manually operable means connected to the first control input for the memory for causing the memory to increase the value stored and second manually operable means connected to the second control input for the memory for causing the memory to decrease the value stored.

Such a memory may suitably be a binary counter.

Preferably the counter has a clock input, a "count-up" input, a "count-down" input and a "reset" input. Suitably the counter counts pulses applied to the clock input when either the count-up or count-down inputs are operated. When the count-up input is operated, the pulses applied to the clock input are counted upwards by the counter so that the count achieved by the counter is thereby increased. Similarly when the count-down input is operated the counter counts downwards, the pulses applied to the clock input serve to decrease the count stored by the counter. The reset input is suitably operable to reset the counter to its lowest counting value which preferably corresponds to a zero energy supply rate to the load.

Preferably the counter input, count-down input and reset input are each connected to a respective proximity detector according to the invention via respective switching circuits. The arrangement is such that the presence of an operator's finger in contact with or closely spaced from one of the proximity detectors causes the respective input to the counter to be activated. These proximity detectors may be mounted on a control panel, the arrangement being such as that described and claimed in our copending Divisional Application No. 47991/75 (Serial No. 1,464,094).

In order that the invention will more clearly be understood, the following description is given, merely by way of example, reference being made to the accompanying drawings, in which:—

Figure 1 is a block schematic diagram of a power control apparatus for use with an electric cooker heating element; and

Figure 2 is an exploded front elevation of a control panel incorporating proximity detectors in accordance with the inventtion for controlling the power control apparatus of Figure 1.

Figure 1 shows a power control apparatus which comprises an electronic counter 1 having ten output lines generally designated 11, each output line carrying an output signal when a corresponding count is achieved, and three control inputs 12, 13 and 14, these inputs causing the countr to count-up, count-down and reset to zero respectively. The counter 1 may be of a conventional recycling type in which case logic circuits are provided which prevent it from counting up beyond a count of nine and counting down beyond a count of zero.

A display 6 is connected to the outputs of counter 1 via a suitable driving circuit (not shown). Although display 6 is shown in Figure 1 as being connected to a separate output, the display 6 could of course be connected to lines 11. Any suitable device may be used as display 6 although a seven segment display of the L.E.D. or liquid crystal type is preferred.

The inputs 12, 13 and 14 of counter 1 are driven by the outputs of proximity switches 2, 3 and 4 respectively and each proximity switch is arranged so that it produces an output only when its operating surface is touched by an operator. Counter 1 is arranged so that it will retain a fixed count until one of the control inputs 12, 13 and 14 is operated.

Each of the proximity switches 2, 3 and 4 includes a respective proximity detector and associated switch circuits. The switch circuits may be of any of the known types which are adapted to produce an output signal in response to the presence of an object such as operator's finger in close proximity with or in contact with the associated proximity detector. For instance, each proximity detector output electrode may be connected to the gate of a MOS field effect transistor and the source or drain circuit of the transistor may include a load resistor so that an output signal may be developed across the drain and source of the transistor.

A strobe 5 is provided which delivers to the clock input 16 of counter 1 pulses which preferably occur at approximately 0.2 or 0.5 second intervals. The strobe 5 may consist of a digital dividing network driven

by pulses derived from the 50 hertz electrical mains supply.

The pulses delivered to the clock input 16 of counter 1 are the pulses which are effectively counted when either of its inputs 12 or 13 is operated.

Each output line 11 is connected to a respective input of a burst fire controller 7, whose output is connected to the gate of a triac 9, which in turn controls the flow of electric current to a heating element or elements 10 which may be included in a cooker hot-plate.

Triac 9 is operated in the "burst fire" mode. That is to say that it is operated to supply pulses consisting of a whole number of supply cycles of mains alternating current to the heating element. By varying the mark to space ratio of the pulses, the width of the pulses and thereby the rate of energy supply to the heating element 10 can be varied as desired. For example, a long pulse or mark separated by a short space will have the effect of supplying a relatively large amount of energy to the heating element per unit time whereas a short pulse or mark and a long space wil cause a relatively small amount of energy per unit time to be supplied to the heating elements 10.

A delay switch 8 is arranged so that when counter 1 is holding a steady count, the current supplied to heating element 10 is proportional to the count stored. However, of the "count-up" proximity switch 2 is operated switch 8 causes triac 9 to produce an output current which corresponds to the maximum heating rate from heating element 10. A thermal sensor 15, e.g. an infra-red sensor may be provided located adjacent the heating element 10. Thermal sensor 15 produces an output signal which is proportional to the temperature measured and which may be fed to an input (not shown) of delay switch 8. When a predetermined temperature is registered by sensor 15, switch 8 is de-activated so that triac 9 produces an output current which is proportional to the count stored by counter 1.

Delay switch 8 also includes a further input (not shown) which is arranged to be activated when the count-down proximity switch 3 is operated. Delay switch 8 then causes triac 9 to produce zero output current until a second predetermined temperature is registered by temperature sensor 15.

Figure 2 shows a control panel incorporating proximity detectors in accordance with the invention. The panel comprises metallic elements 17, 19 and 20 as shown mounted on a glass plate 31, the metallic elements 17, 19 and 20 being separated from one another by a zone 18. Corresponding metallic layers 17*a*, 19*a* and 20*a* respectively are located in alignment on the opposite face of glass plate 31. Each of the metallic elements 17*a*, 19*a* and 20*a* is connected to a respective electrical switch circuit which can detect the flow of current to and/or from the element. The elements 17. 19 and 20 are insulated by a thin coat of non-conducting lacquering over their whole surface and from elements 17*a*, 19*a* and 20*a* by the glass plate 31. Preferably the lacquer is a glass-like or ceramic material.

When an operator places a finger on any one of the elements 17, 19 or 20, the corresponding element 17*a*, 19*a* or 20*a* is capacitively coupled to earth by virtue of the dielectric properties of glass plate 31, since the operator's body will generally be at approximately earth potential and his electrical resistance will be much less than the glass plate 31.

The proximity detector circuits associated with each element 17*a*, 19*a* and 20*a* are adapted to produce an output signal whenever the corresponding element 17, 19 or 20 is touched by an operator. Preferably the proximity detector circuit associated with element 17*a*, 19*a* and 20*a* are connected to the "reset" 14, "count-up" 12 and "count-down" input 13, respectively of counter 1.

Preferably all the circuit elements shown in Figure 1 except triac 9 and heating element 10 are powered from a low voltage direct current source one of whose supply rails is connected to the "live" terminal of the mains supply.

In this arrangement, when an operator places his finger on one of the elements 17, 19 or 20, the electrode touched is effectively coupled to earth and causes a capacitive charging current to flow to or from the corresponding element 17*a*, 19*a* or 20*a* since these elements are connected to switches one of whose supply rails is connected to the 'live' terminal of the mains and thus all of the elements 17*a*, 19*a* and 20*a* are maintained at an alternating voltage of the order of the mains supply voltage above earth. A respective switch senses the capacity charging current which is thus caused to flow and produces an output signal. Since elements 17, 19 and 20 are electrically conductive, the capacitive coupling between each element and its corresponding element 17*a*, 19*a* or 20*a* is rendered independent of the size or shape of the operator's finger and the manner in which it is applied to the electrode.

A further advantage of the arrangement shown in Figure 2 is that if the front panel constituted by elements 17, 19 and 20 and display 6 is cleaned by, for instance, wiping a cloth, the last element which will be touched by the cloth will be element 17 and this will cause its associated switch to deliver an output signal to the reset input 14 of counter 1 thus turning off the electrical

supply to the heating element 10. Thus there is no danger of the cooker being inadvertently switched on by operation of element 19 since such an operation will always be followed during cleaning by the operation of the switch associated with element 17.

In order to prevent stray fields behind elements 17*a*, 19*a* and 20*a* from operating their associated switches a further sheet of dielectric material 32 may be located behind elements 17*a*, 19*a* and 20*a* and behind this a further sheet of conductive material 33 which may for instance be connected to the zero volt rail supplying the control elements.

Sheet 33 will effectively form a screen to prevent operation of any of the proximity detectors by stray fields from behind.

Preferably display 6 is located behind the glass sheet 31 to facilitate connection to its driving circuits and also to protect it from damage.

Although it is not shown in the Figures a pulse transformer may be used to couple burst fire controller 7 to the gate of triac 9. Whilst not essential this will ensure that there is no danger to either the operator or the other control elements should breakdown of triac 9 occur. The operator is further protected in that the only portions of the apparatus accessible under normal circumstances are elements 17, 19 and 20 and these are electrically insulated from all the other circuit elements.

WHAT WE CLAIM IS:—

1. A proximity detector having a front, surface which, in normal use, faces an operator and including an insulating plate member having first and second major faces which in normal use face away from and towards an operator, respectively, at least one first electrode on the first face of the insulating plate and at least one second electrode on the second face of the insulating plate, the or each first electrode being capacitively coupled with the or the respective second electrode through the plate, the or each second electrode defining a or a respective proximity sensing area on said front surface of the detector whereby the or the respective first electrode is responsive, to produce an output signal, both to the presence of an operator's finger in contact with such area and to the presence of such finger in close proximity to the, or the respective, such area, only the or each electrode on said first face of the insulating plate member having an electrical connection for coupling to an electrical circuit.

2. A proximity detector according to claim 1, wherein the insulating plate is a glass sheet.

3. A proximity detector according to claim 1 or 2, wherein three such first electrodes and three such second electrodes are mounted on said insulating plate member thereby providing three such proximity sensing areas which are separate from one another.

4. A proximity detector according to claim 1, 2 or 3, wherein at least the or each second electrode is coated with non-conducting lacquer so that the or each second electrode is completely insulated from the exterior of the detector.

5. A proximity detector substantially as hereinbefore described and illustrated in Figure 2 of the accompanying drawings.

6. An electric cooker having at least one proximity detector according to any one of the preceding claims.

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1464095 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

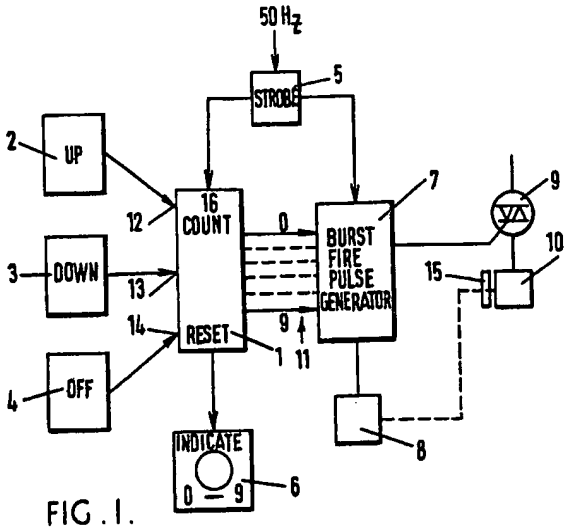

FIG. 1.

FIG. 2.